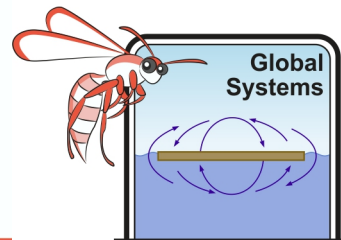


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Adapting to a Changing Climate

Through geological time, Earth's climate has fluctuated, including cycles of extreme warming and cooling which have impacted on the plant and animal species that inhabit the planet.

There is clear evidence to indicate that the Earth is currently in a trend of climatic warming. This change is rapid and is most likely (>95% probability) as the result of human activity (NASA Global Climate Change, 2021).

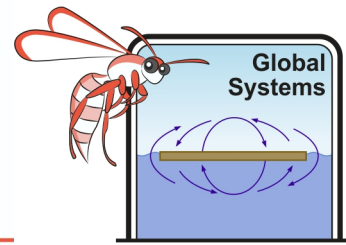
NASA has been monitoring long term changes in the global climate and, in 2008, reported nine indicators of rapid climate change.

ACTIVITY: Visit <https://climate.nasa.gov/evidence/> to complete the table of rapid climate change indicators.

Indicator	Change
Global temperature rise	
Warming ocean	
Shrinking ice sheets	
Glacial retreat	
Decreased snow cover	
Sea level rise	
Declining Arctic Sea ice	
Extreme events	
Ocean acidification	

Locally, communities are noting changes to their surrounds that can be attributed to a warming climate. Recent studies have identified impacts on humans such as loss of homes and agricultural lands with a rise in sea level, and changes to animal behaviour including an alteration to the wintering sites of marine animals (Reyes-García, V., Fernández-Llamazares, Á., Guèze, M., Garcés, A., Mallo, M., Vila-Gómez, M., & Vilaseca, M., 2016).

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Global Action



Source: [United Nations](https://www.un.org/sustainabledevelopment/)

Leaders around the world have recognised that global warming is a major environmental issue that will change the way we live. In 1997, the United Nations (UN) established a goal to maintain or decrease atmospheric greenhouse gas concentrations at their current levels across the planet.

Seven greenhouse gases were targeted for reduction:

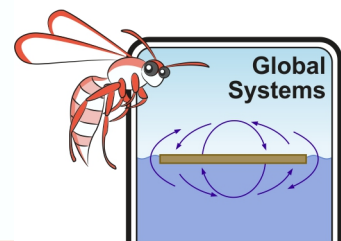
- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)
- Perfluorocarbons (PFCs)
- Hydrofluorocarbons (HFCs)
- Nitrogen trifluoride (NF₃)₃
- Sulfur hexafluoride (SF₆)



Each of these greenhouse gases traps reradiated infrared radiation from the Earth's surface, leading to warming. Carbon dioxide (CO₂) is the most common greenhouse gas released by human activity. It is assigned a global warming potential (GWP) of 1. The GWP of the other greenhouse gases are measured against CO₂, providing an indication of their impact on the warming climate. This measure is called the carbon dioxide equivalent, or CO₂e.

The table below compares the GWP of the seven greenhouse gases.

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ACTIVITY: Research to identify the main source of each of these greenhouse gases

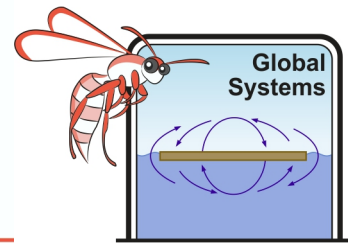
Gas	Global Warming Potential (GWP)	Source/s
Carbon dioxide (CO ₂)	1	
Methane (CH ₄)	25	
Nitrous oxide (N ₂ O)	298	
Perfluorocarbons (PFCs)	12 200	
Hydrofluorocarbons (HFCs)	14 800	
Nitrogen trifluoride (NF ₃) ₃	17 200	
Sulfur hexafluoride (SF ₆)	22 800	

ACTIVITY: Calculate the CO₂e from the release of the following amounts of greenhouse gases

Amount of GHG	GWP	Calculation	CO ₂ e
1kg methane	25	$1\text{kg} \times 25 = 25\text{kg}$	25kg
20g SF ₆	22 800		
1 tonne CO ₂	1		
500g (NF ₃) ₃	17 200		
1.5kg N ₂ O	298		
50g Hydrofluorocarbon	14 800		

Industry Actions

Countries, regions, cities, and companies are establishing net zero targets to reduce the amount of atmospheric greenhouse gases. The actions towards meeting these targets are measured as emissions reductions or carbon offsets.



Carbon Offsets – Student Activity



Source: [World Economic Forum](#)

Meeting net zero targets – carbon offsets

Carbon offsets can measure how much an action reduces the amount of greenhouse gas released into the atmosphere or how much it removes. A carbon offset or emissions reduction activity is classified under the following categories:

- Prevent the release of greenhouse gases, e.g. switching to 100% renewable energy power generation
- Reduce the amount of greenhouse gas that is released, e.g. using a hybrid system to generate power
- Remove greenhouse gases that are already in the atmosphere, e.g. planting trees to remove CO₂ (via photosynthesis)

These activities generate carbon offsets, which are units of measure related to reductions or removals of greenhouse gas in the atmosphere.

The Paris Agreement has set clear goals for greenhouse gas emission reductions. This has provided the opportunity for Australian companies, both large and small, to develop emission reduction goals in accordance with this agreement.

Review the following sites to compare the two case studies below:

Case Study 1: Large Industry – Woodside Energy Ltd

AIM - net zero in their direct emissions by 2050 or sooner

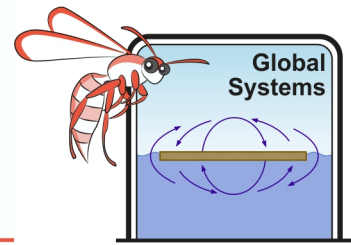
[Part of a lower carbon future, November 2020](#)

Case Study 2: Small Industry - Red Rock Drilling

AIM - net zero in their direct emissions, effective immediately

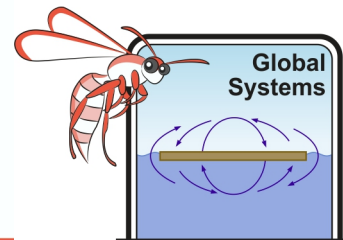
[Resourc.ly, February 2021](#)

Carbon Offsets – Student Activity



ACTIVITY: Use your research to complete the table

Organisation	Emissions reduction and carbon offset activities
Woodside Energy Ltd	
Red Rock Drilling	



Carbon Offsets – Student Activity

Individual – my CO₂e?

The warming climate is a global issue. Each of us contributes to the amount of greenhouse gases in the atmosphere. How much do we contribute individually? As individuals, can we offset our own carbon emissions?

The first step is to measure our CO₂e.

As a starter, the following activity investigates one component of our daily life – how we get to and from school each day.

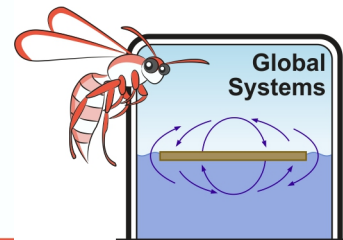


ACTIVITY: Work through the activity steps to calculate the CO₂e for your commute. Calculate for your most common daily transport form.

1. Work in groups of four students
2. Using the following website, complete the details for each member of your group:
<https://www.greenvehicleguide.gov.au/>.
 Use Google Maps to accurately measure the distance of your return journey from home.

Student name	Transport type	Fuel type	Tailpipe CO ₂ – Urban (g/km)	Return distance from home to school (km)	Calculate CO ₂ e (g) (CO ₂ *distance)
AVERAGE					

3. Create a column graph of the CO₂e for each student.
4. Calculate the average CO₂e of the group (add each student's CO₂e and divide by the number of group members).
5. Discuss your thoughts on being assigned an average CO₂e if you rode your bike or walked to and from school (i.e., moving from zero CO₂e to an average CO₂e).
 Relate this to the global issues of a warming climate if you are a nation or organisation which has low greenhouse gas emissions.



Carbon Offsets – Student Activity

6. If you have time, construct a table or graph of group CO₂e averages for the class and discuss.
7. Extension:

Design an investigation to measure other ways in which you release greenhouse gases.



Source: [Wikimedia](#)

Now that you have an idea of how much CO₂e you generate each day, you can start to investigate ways to offset your greenhouse gas emissions, or your individual CO₂-e.

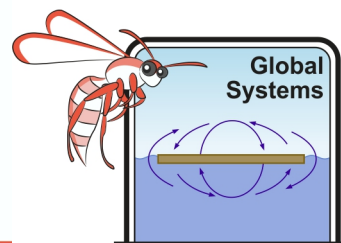
ACTIVITY: In your groups, suggest activities to offset your carbon. Research how much CO₂e each activity will offset and record on the table.

Student	Prevent	Amount of CO ₂ -e	Reduce	Amount of CO ₂ -e	Remove	Amount of CO ₂ -e

To get you started, consider the following:

- Find ways to get to and from school without generating CO₂e
- Participate in a local planting event
- Plan a space in the school / community for tree planting
- Calculate the carbon footprint of your school and investigate ways to reduce this at <https://www.climateclever.org/schools>
- Visit <https://www.gviaustralia.com.au/blog/6-critical-global-issues-what-are-the-worlds-biggest-problems-and-how-i-can-help/>
- Explore other ways you generate CO₂e by calculating your Carbon Footprint at <https://calculator.carbonpositiveaustralia.org.au/>

Carbon Offsets – Student Activity



Future thinking

IS IT POSSIBLE TO REMEDIATE A GLOBAL PROBLEM?

Research other examples of nations collaborating across the world to manage a global issue, e.g. reducing the use of chlorofluorocarbons (CFCs) to prevent excessive depletion of the ozone layer.

References

Reyes-García, V., Fernández-Llamazares, Á., Guèze, M., Garcés, A., Mallo, M., Vila-Gómez, M., & Vilaseca, M. (2016). Local indicators of climate change: The potential contribution of local knowledge to climate research. *Wiley interdisciplinary reviews. Climate change*, 7(1), 109–124. Accessed at: <https://doi.org/10.1002/wcc.374>

NASA Global Climate Change (2021). *Vital Signs of the Planet*. Earth Science Communications Team, NASA's Jet Propulsion Laboratory, California Institute of Technology. Accessed at: <https://climate.nasa.gov/evidence/>

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